MEASUREMENT AND ANALYSIS TECHNIQUES FOR PRECISE ENGINEERING AND MEDICAL APPLICATIONS

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ABSTRACT

Many applications (especially engineering and medical) require precise measurement, ranging from micron-level (i.e. mechanical engineering applications) to cm-level (civil engineering applications). To date, many precise measurement techniques are available, such as Laser Scanner/Tracker, Close Range Photogrammetry, Global Positioning System (GPS), Total Station, Coordinate Measuring Machine (CMM), etc. This paper describes the on-going research works related to measurement and analysis for precise engineering and medical applications. The engineering applications are divided into 2 modules: deformation analysis and industrial applications. The deformation analysis module comprises of software development (GPSAD2000, DEFORM99, DEFORM) for processing data (from GPS, total station, geodetic/geotechnical techniques) for deformation analysis, development of interface to commercial software (STARNET, TGO), the applications of APSWIN (commercial monitoring software), and inter-disciplinary research with civil engineers. The industrial applications module also involves software development, and uses commercial systems/software (VIVID910 Laser Scanner system, V-STARS photogrammetric system, AXYZ system with Precision Total Station/Electronic Theodolite, PHOTOMODELER photogrammetric software, RHINOCEROS 3D modeling software) for inter-disciplinary research with mechanical engineers. The medical application module concentrates on the development of system/software for inter-disciplinary craniofacial applications (UTM, SIRIM, USM) and uses various systems/software (VIVID910 Laser Scanner system, DVD photogrammetric software, AUSTRALIS photogrammetric software, RAPIDFORM 3D modeling software). All the above research works also involve verification tests with other techniques/software (such as CMM system and STARNET software). The research findings to date show the importance of inter-disciplinary research works for both engineering and medical applications.

1.0 INTRODUCTION

Many applications (especially engineering and medical) require precise measurement, ranging from micron-level (i.e. mechanical engineering applications) to cm-level (civil engineering applications). To date, many precise measurement techniques are available, such as Laser Scanner/Tracker, Close Range Photogrammetry, Global Positioning System (GPS), Total Station, Coordinate Measuring Machine (CMM), etc.

This paper describes the on-going research works (at the Faculty of Geoinformation Science & Engineering, Universiti Teknologi Malaysia (UTM)) related to measurement and analysis for precise engineering (section 2) and medical (section 3) applications.

2.0 PRECISE ENGINEERING APPLICATIONS

The engineering applications are divided into 2 modules: deformation analysis (section 2.1) and industrial applications (section 2.2).

2.1 Deformation analysis module

The deformation analysis module comprises of software development (e.g. GPSAD2000, DEFORM99, DEFORM) for processing data (from GPS, total station, geodetic/geotechnical techniques) for deformation analysis, development of interface to commercial software (STARNET, TGO), the applications of APSWIN (commercial monitoring software), and inter-disciplinary research with other disciplines (e.g. civil engineers).

GPSAD2000 is a windows-based software system specially developed for 3-D deformation detection via geodetic methods (Halim & Bong, 2001). The main components of GPSAD2000 are: least squares estimation (LSE) or adjustment of GPS baseline vectors, 3-D deformation detection (via congruency testing) and graphical visualization. All these components are integrated in one environment using Visual Basic. Currently, interfaces are developed for linking GPSAD2000 to commercial software (Figure 1) such as STARNET and TGO (Halim & Mohd. Sharuddin, 2003).

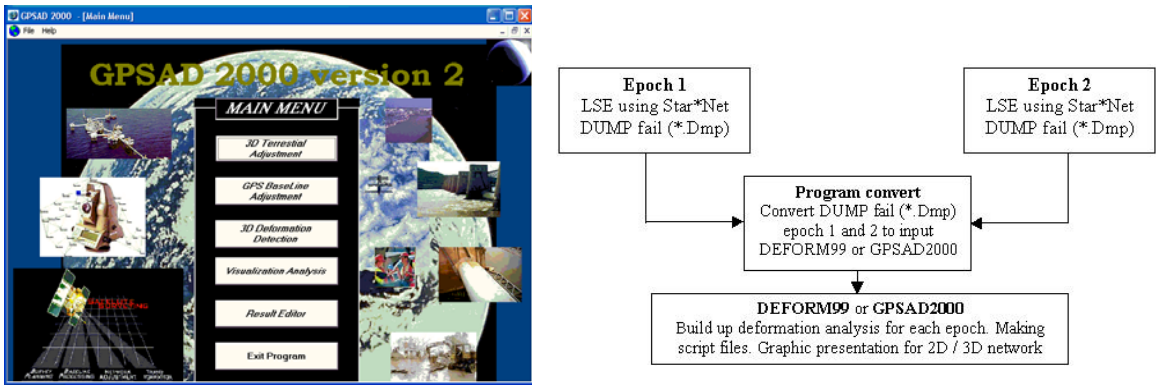

Figure 1. GPSAD2000 and the development of interface

Among current research activities are the improvement of GPSAD2000 (Halim et al, 2004), integrated deformation analysis (Halim & Yul, 2004), deformation analysis via close range digital photogrammetric (Halim & Mohd. Sharuddin, 2004c) and inter-disciplinary research with civil engineers (Halim et al, 2003).

2.2 Industrial applications module

The industrial applications module focuses on the development of procedure and uses commercial systems/software (VIVID910 Laser Scanner system, V-STARS photogrammetric system, AXYZ system with Precision Total Station/Electronic Theodolite, PHOTOMODELER photogrammetric software, RHINOCEROS 3D modeling software, RAPIDFORM software) for inter-disciplinary research with others (i.e. mechanical engineers, archeologists). Software development activities are related to low-cost software for industrial surveying and engineering surveying.

The research works deal mostly with precise measurement using (Figure 2) various sensors (micron to cm level), 3D modeling of objects (Figure 3) for mechanical engineering applications (Halim & Mohd. Sharuddin, 2004a), and also for archeological applications (Halim & Mohd. Sharuddin, 2004b; Halim & Ismail, 2004).

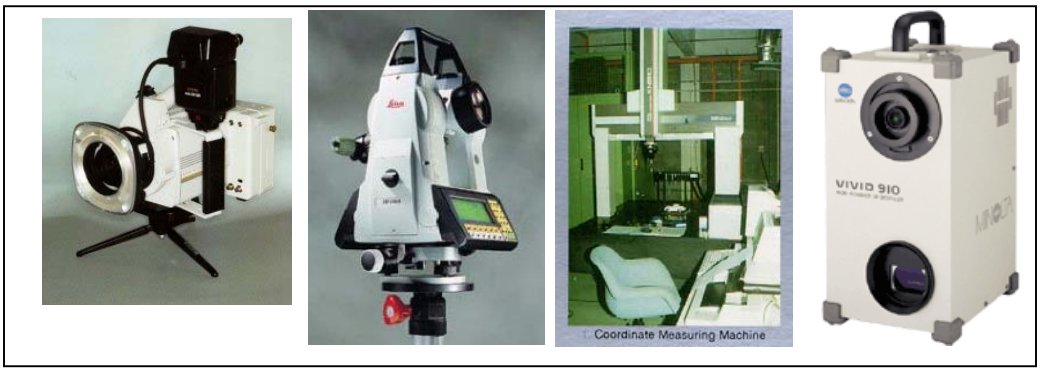

Figure 2. V-STARS, AXYZ, CMM, VIVID 910

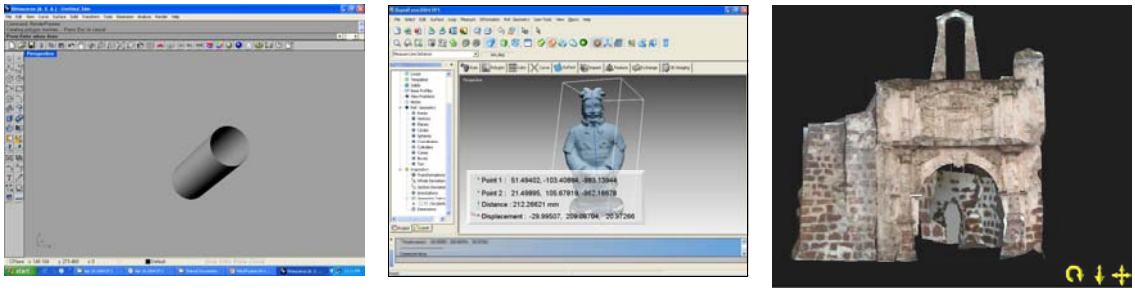

Figure 3. Precise measurement and 3D modeling

3.0 MEDICAL APPLICATIONS

The medical application module concentrates on the development of system/software for multi-disciplinary research, and uses various systems/software (VIVID910 Laser Scanner system, DVD photogrammetric software, AUSTRALIS photogrammetric software, RAPIDFORM 3D modeling software).

The multi-disciplinary research is established between Universiti Teknologi Malaysia (UTM), Standards & Industrial Research Institute Malaysia (SIRIM), and Universiti Sains Malaysia (USM). The research focuses on the development of surgical planning system for craniofacial reconstruction, for both the soft and hard tissues. UTM concentrates on the development of a close range image capturing system (Figure 4) and information system for craniofacial soft tissue (Zulkepli et al, 2004; Deni et al, 2004).

4.0 CONCLUSIONS

This paper describes the on-going research works related to measurement and analysis for precise engineering and medical applications. All the above research works also involve verification tests (Halim & Mohd. Sharuddin, 2004a) with other techniques/software (such as CMM system and

STARNET software). The research findings to date show the importance of inter-disciplinary research works for both engineering and medical applications.

Figure 4. Close range image capturing system for craniofacial

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REFERENCES

Deni Suwardi, Intan Sajidah Abd. Aziz, Halim Setan, Zulkepli Majid, Anuar Ahmad & Albert Chong (2004). An innovative information system to support a nation-wide database for normal and malformation craniofacials. Presented at the 3D Modelling 2004, Paris, 28-29 April, 2004.

Halim Setan & Bong Chin Nyet (2000). GPSAD2000: A software system for GPS baseline adjustment, deformation detection and visualization analysis. Presented at the 4th Asia-Pacific Conference on Structural Engineering and Construction (APSEC) 2000, Kuala Lumpur, 13-15 September, 2000.

Halim Setan & Ismail Ma'arof (2004). Permodelan 3D Porte de Santiago (A Famosa) menggunakan kaedah fotogrametri digital. Presented at Persidangan kebangsaan sains dan teknologi dalam pemuliharaan warisan negara, Melaka, 16-19 August, 2004.

Halim Setan & Mohd Sharuddin Ibrahim (2003). Procedure for deformation detection using STARNET. Presented at the 11th International Symposium on Deformation measurement, Greece, 25-28 Mei, 2003.

Halim Setan & Mohd Sharuddin Ibrahim (2004a). Close range measurement and 3D modeling. Presented at the 1st International Symposium on Engineering Surveys for Construction Works and Structural Engineering, Nottingham (United Kingdom), 28 June-1 July 2004.

Halim Setan & Mohd Sharuddin Ibrahim (2004b). Kaedah pengukuran laser dalam perekodan artifak bersejarah. Presented at Persidangan kebangsaan sains dan teknologi dalam pemuliharaan warisan negara, Melaka, 16-19 August, 2004.

Halim Setan & Mohd Sharuddin Ibrahim (2004c). Procedure for deformation detection using vision metrology. Presented at the International Symposium and Exhibition on Geoinformation 2004, Kuala Lumpur, 21-23 September, 2004.

Halim Setan, Muhammad Asyran, Ernyza Endot & Mohd Sharuddin Ibrahim (2004). The improvement of GPSAD2000 software system for complete deformation analysis in one environment. Presented at the Malaysian Science & Technology Congress (MSTC) 2003, Kuala Lumpur, 5-7 October 2004.

Halim Setan & Yul Amri (2004). Estimation and modeling for deformation monitoring using geodetic methods. Presented at the International Symposium and Exhibition on Geoinformation 2004, Kuala Lumpur, 21-23 September, 2004.

Halim Setan, Zainal Abidin Md Som & Khairulnizam M. Idris (2003). Robust estimation and deformation modelling of lightweight concrete block. Presented at the International Symposium and Exhibition on Geoinformation 2003, Kuala Lumpur, 13-14 October, 2003.

Zulkepli Majid, Halim Setan, Albert Chong & Anuar Ahmad (2004). Modeling human faces with non-contact three dimensional digitizer. Presented at the 3D Modelling 2004, Paris, 28-29 April, 2004.